PROGRAM & ABSTRACTS

ROCKY MOUNTAIN HYDROLOGIC RESEARCH CENTER
48TH ANNUAL MEETING

SCIENCE, ENGINEERING, AND MANAGEMENT

Saturday, September 18, 1993, 9:15 am to 4 pm
Wild Basin Lodge near Allenspark, Colorado

ROCKY MOUNTAIN HYDROLOGIC RESEARCH CENTER, 48TH ANNUAL MEETING
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September 18, 1993, 9:15 am - 4:00 pm

Nolan Doesken, Colorado Climate Center, Recent Climate Variations in Colorado, What do they tell us?

Briant Kimball and Katie Walton-Day, U. S. Geological Survey, Sediment-water exchange of metals influenced by colloids in a river receiving acid mine drainage, Upper Arkansas River, Colorado

Sandra Ryan, INSTAAR, Univ. of Colorado, and Chuck Troendle, U.S. Forest Service, Sediment transport in a diverted stream system, St. Louis Creek, Colorado

Wentao Liu, Riverside Technology (RT), John Labadie, Colorado State University, Larry Brazil, RT, Combining NWS extended streamflow prediction (ESP) and dynamic programming to improve reservoir system operations

Enan Jayyousi and David Bowles, Utah State University, Flood routing techniques for incremental damage assessment

James Guo, University of Colorado, Determination of critical flow in a spatially varied flow

Gilbert Urroz, and C. Earl Israelson, Utah State University, Erosion control testing under simulated rainfall and in high-velocity flows

Jorge Ortiz Zayas, U.S. Geological Survey and University of Colorado, Stream metabolism studies at the North Saint Vrain River near Allens Park, Colorado during summer 1993.

RMHRC Fieldtrip at Wild Basin Lodge (3:00 - 4:00 pm)

Julie Sueker, U.S. Geological Survey and University of Colorado, Surface water chemistry and hydrology of subalpine watersheds in Rocky Mountain National Park, Colorado

Doug Thompson, U.S. Geological Survey and Colorado State University, Sediment transport studies in North St. Vrain Creek near Allens Park, Colorado

For additional information: Robert Jarrett (303)236-6447

Abstract

Recent Climate Variations in Colorado
What Do They Tell Us?

by

Nolan J. Doesken
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The Colorado Climate Center routinely monitors various aspects of Colorado climate from numerous cooperative weather stations across the State. Many local climate records date back 100 years or more. Long-term consistent climate data from mountainous areas, however, is generally not available for more than a few decades.

Time series of several climate variables will be presented for selected areas of Colorado including seasonal temperatures and winter and summer precipitation. Winter snowpack time series will be shown for the St. Vrain basin and compared to other areas of the Rockies. Several other less common series, such as annual extreme temperatures, snowstorm frequencies, tornado frequencies, drought indices and winter-summer temperature and precipitation differences will be displayed. Interpretations will be offered, and implications for Colorado's future will be discussed.

Submitted to 48th Annual Meeting of the Rocky Mountain Hydrologic Research Center to be held September 18, 1993 near Allenspark, Colorado.

SEDIMENT-WATER EXCHANGE OF METALS INFLUENCED BY COLLOIDS IN A RIVER RECEIVING ACID MINE DRAINAGE, UPPER ARKANSAS RIVER, COLORADO, U.S.A.

Briant A. Kimball[1] and Katie Walton-Day[2]

Inflows of metal-rich, acidic water that drain from mine dumps and tailings piles in the Leadville, Colo., area enter the non-acidic water in the upper Arkansas River. Colloidal iron oxyhydroxides precipitate and move downstream in suspension, particularly downstream from California Gulch, which was the major source of metal loads before recent remediation efforts. The colloids influence water-sediment interaction of other metals. To determine trends of metal concentrations in the water column and bed sediment, samples of both were obtained at stream-gaging sites on the upper Arkansas River and the major tributaries over a 250-km reach. Filtered and colloidal concentrations in the water column were operationally defined using tangential-flow filtration through 100,000 dalton nominal pore-size and 0.45 μm membranes. Surface-extractable and total bed sediment concentrations were obtained on the less than 60-mm fraction of the bed sediment. Iron predominated in the colloidal phase in the water column. Iron-rich colloids provide surface area for sorption of toxic metals. Although colloids were lost through sedimentation, little surface-extractable iron occurred in bed sediment, indicating little sediment-water interaction. Manganese and zinc occurred mostly in the filtered phase (less than 100,000 daltons) in the water column. Both metals occurred mostly as extractable coatings of the bed sediment, consistent with sediment-water interaction. In this colloid-rich system, substantial metal loads are transported by colloids and by bed sediment.

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Sediment Transport in a Diverted Stream System, St. Louis Creek, Colorado

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C.A. Troendle, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, 240 W. Prospect Rd., Fort Collins, CO 80526-2098.

This paper reports on a study of flow and sediment transport in diverted and free flowing segments of St. Louis Creek near Fraser, Colorado. St. Louis Creek is a high gradient, single-thread channel where 40 to 50 percent of the total annual flow, derived primarily from snowmelt, has been diverted since 1956. Bedload movement and velocity were measured on a near daily basis over a seven week period in the spring of 1992. The instantaneous peak discharge was 4.16 m^3 s^{-1} or roughly 60 percent of the unaltered bankfull flow. Sampling was stratified by channel type and included: (1) *constrained* channels which are tightly bound by the valley wall with boulder-beds, steep gradients (>0.04), and a step-pool topography and (2) *unconstrained* channels flowing in wide valley floors with gravel to cobble beds, more gentle gradients (0.01 to 0.02), and a pool-riffle topography.

Similar transport rates were observed in diverted and free-flowing segments as diversion during peak runoff was slight and peak flows were less than bankfull. Still, the measurements provide some insight into the interaction between discharge and sediment movement under lower flows. Bedload movement was low and sporadic at all sites during the period prior to peak runoff. An increase in transport occurred on the rising limb at unconstrained sites but remained slight at constrained sites. Transport quickly subsided at unconstrained sites after the peak while it increased and remained substantially higher for several days at constrained sites. Peak transport rates at unconstrained sites were between 0.008 and 0.010 kg $m^{-1}s^{-1}$ and 0.008 and 0.014 kg $m^{-1}s^{-1}$ at constrained sites. Bedload particles were primarily granule and pebble sized (2 to 15 mm) at all sites, though small cobbles approaching the median bed particle size (80 mm) were also trapped at unconstrained sites. It appeared the beds of the constrained reaches were largely undisturbed while the beds of unconstrained sites were partially mobile; these observations were corroborated using evidence from a painted rock study. Bedload from constrained sites may have originated at unconstrained sites upstream and simply washed through the constrained sites, based on differences in timing of peak transport and the similarity of the particle sizes moved.

Additional sampling is planned for the peak runoff in the spring of 1993 as greater than bankfull flows are anticipated from a substantially larger snowpack.

Combining NWS Extended Streamflow Prediction (ESP) and Dynamic Programming to Improve Reservoir System Operations

Wentao Liu[1], John W. Labadie[2], and Larry E. Brazil[3]

Abstract

The economic benefits of effective water supply forecasts which include probabilities for forecast realization have been described in conceptual terms for several years. the National Weather Service River Forecast System (NWSRFS) Extended Streamflow Prediction subsystem (ESP) provides water managers with valuable probabilistic long-term streamflow forecast information. The forecasts have not been fully used in operations, most likely because first, it is difficult to use the risk-related forecast information, and second, although the water managers have to take some risk the risk level has not been clearly specified. The authors introduce a Water Resources Forecast Service (WARFS) demonstration project sponsored by the NWS, Riverside Technology, inc., the Denver Water Department, Colorado State University, and the Bureau of Reclamation. A methodology of combining the ESP forecast information and the dynamic programming technique is developed and applied to the Blue River and the Williams Fork River, the tributaries of Colorado River in the Rocky Mountain area. The results show that substantial economic benefits can be obtained by incorporating the NWSRFS ESP forecasts into reservoir operating decisions.

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Abstract

FLOOD ROUTING TECHNIQUES FOR INCREMENTAL DAMAGE ASSESSMENT

Enan Fakhri Jayyousi[1], and David S. Bowles[2]

Dam safety standards have become more stringent in the past fifteen years since the failure of several dams in the United States, including Teton Dam in Idaho. The cost of bringing existing dams into conformance with modern standards can be very high. Incremental damage assessment has become more widely used as a tool for justifying the hydrologic base safety condition.

Incremental damage assessment provides a means of determining whether or not costly dam modifications will significantly improve the safety of downstream residents and their property. Flood routing is used to investigate the extent and character of flooding below a dam. Since the essence of incremental damage assessment is examining the difference in flooding with and without a dam failure, it is essential that flood routing be performed using a suitably selected and properly applied method. Conclusions drawn from the incremental damage assessment results might be distorted if the available computer programs for dam bread flood routing are inappropriately applied.

In this paper the role of flood routing and dam break models in incremental damage assessment is analyzed. Uncertainties in flood routing results are explored in terms of their effect on the conclusions which are drawn from an incremental damage assessment. The discussion draws on some preliminary comparisons of commonly used flood routing procedures for actual and hypothesized dam break cases. The goal of the study is to develop guidelines for use in conducting and interpreting incremental damage assessments.

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DETERMINATION OF CRITICAL FLOW IN A SPATIALLY VARIED FLOW

by
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Spatially varied flow is a steady but nonuniform flow. Its discharge constantly increases with respect to distance. A type example of spatially varied flow is collector channels that collect water spilt over a weir with a constant head.

Analysis of water surface profile for a spatially varied flow is a complicated procedure due to the variation of discharge. The very first step in the water surface profile analysis is to locate the control section where critical flow occurs. Critical flow condition is defined as Froude number equal to unity.

$$\frac{Q^2\ T}{g\ A^3} = 1$$

$$Q = q\ x$$

in which Q = discharge, T = channel top width, g = gravitational acceleration, A = flow area, q = inflow rate per foot, and x = distance. A graphic method was developed to approximately solve the above two equations in order to locate the critical flow section. The procedure is too cumbersome to apply to real cases.

In this paper, a singular point method was developed by simultaneously solving the following two equations:

$$So - Sf - 2\ (Dc/Xc) = 0$$

$$\frac{q^2\ X^2\ Tc}{g\ Ac^3} = 0$$

in which So = channel slope, Sf = friction slope, and D = hydraulic depth. It was found that solutions achieved by the singular point method agree to the graphic method very well. This paper outlines solution procedures with several engineering applications.

Erosion Control Testing Under Simulated Rainfall and in High-Velocity Flows

by
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and
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ABSTRACT

Testing of new or improved erosion control products against existing products becomes an important stage of product development. Testing under reproducible conditions in the laboratory has proven a reliable method of determining the effectiveness of comparable erosion control methods.

Testing of hydromulches, soil binders and other low-velocity erosion control methods can be accomplished by using a rainfall simulator and a test basin where soil plots can be subject to the effects of rainfall under the same controlled conditions of rain intensity, slope and initial moisture. An important aspect of erosion control is the ability of the product to allow plants to grow through it. Plant growth monitoring can be accomplished by using a sunlight simulator. In this paper, a test setup is described that permits the testing of erosion control products under simulated rain and sunlight. The rainfall and sunlight simulators are both 20 ft by 20 ft and the test basin holds 1 foot of soil in plots that are either 2 or 4 ft wide. The basin can be tilted up to 45 degrees for testing in steep slopes. This test set up can also be used for monitoring soil infiltration in hill slopes.

Testing of erosion control mats and blankets and other high-velocity erosion control methods can be accomplished through the use of high-velocity flumes. In this paper, two different high-velocity flumes are described. One consisting of two parallel, horizontal, 4-ft-wide flumes holding 1.5 ft of compacted soil where water velocities ranging from 2 to 30 ft/sec can be achieved. This test set up allows for measurement of erosion depths and for determining failure point of the material tested. These high-velocity flumes have also been used for testing fiberglass and asphalt mats, gabions and reinforced sod. Typical tests are performed in five 30-minute periods with increasing discharge. Long-duration runs, of up to 48 hours, have been performed in some materials.

A second high-velocity flume is used for determining the shear resistance of erosion control products. It consists of a 2-ft wide glass flume with a moving-bed section connected to a force measurement device. Increasing flow discharges are run through the flume and bed forces on the erosion control material monitored until failure occur. Velocities between 2 and 30 feet/sec can also be achieved in this flume.

Stream metabolism studies at the North Saint Vrain Creek, near Allenspark, Colorado

Jorge R. Ortiz Zayas
University of Colorado and
U.S. Geological Survey

Stream metabolism studies were conducted at the North Saint Vrain Creek near Allenspark, Colorado using the diurnal oxygen change one-station analysis. This method was used to estimate productivity and respiration rates in this stream during summer 1993. In this high mountain stream atmospheric oxygen diffusion is an important component of the oxygen balance due to high reaeration rates. A study of diffusion was conducted simultaneously with the dissolved oxygen (DO) diurnal study by using a sealed floating dome. The dome was used to measure the gas transfer rates between the water-air interface by purging it with nitrogen gas. A reaeration coefficient was then determined and used to adjust the DO rate of change for reaeration thus providing only the biological-induced DO rate of change. The study indicated that reaeration rates show a large spatial variability which was evident after placing the dome in different pool and and riffle areas. Stream community gross primary productivity and respiration rates were estimated as 14.6 and 22.6 $g/m^3/day$, respectively. The P/R ratio was less than one indicating that the stream was heterotrophic or dependent on imported organic matter inputs from upstream communities.